Job Tasks, Worker Skills, and Productivity

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NBER-CRIW Summer Institute

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Our Questions

- What is the relationship between productivity and skills, tasks, and occupations at the establishment level?
- How much of the observed dispersion in productivity within detailed manufacturing industries can be accounted for by differences in the organization of workers in terms of skills, tasks, and occupations?

Our Data

- Establishment-level data from:
  - Collaborative Micro-Productivity project (CMP)
    - Census Annual Survey of Manufactures (ASM)
    - Census of Manufactures (CM) – years ending in 2 and 7
  - BLS Occupational Employment and Wage Statistics survey (OEWS)
- We link the OEWS to the Census datasets at the establishment level using a hierarchical set of criteria: EIN, industry (6-digit and 4-digit), state, employment difference
- Sample of approximately 333,000 establishment-year observations covering 86 4-digit manufacturing industries for 2001-2020

- Weights:
  - Inverse propensity score weights (PW)
  - Activity weights (employment)

Mean Employment by Sample

OEWS (weighted)	33
CMP (PW)	53
Linked (unweighted)	222
Linked (PW)	62

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Tasks and Skills

- **Tasks** are activities that when combined with intermediate goods create a good or service and **are the true factors of production** that we would like to measure.
- **Skills** refer to a worker's endowment of capabilities for performing various tasks—complex tasks generally require greater skills.
- An **occupation** can be thought of as a bundle of tasks.
- We do not observe tasks or skills, but we do observe occupations.

Task Measures from O*NET

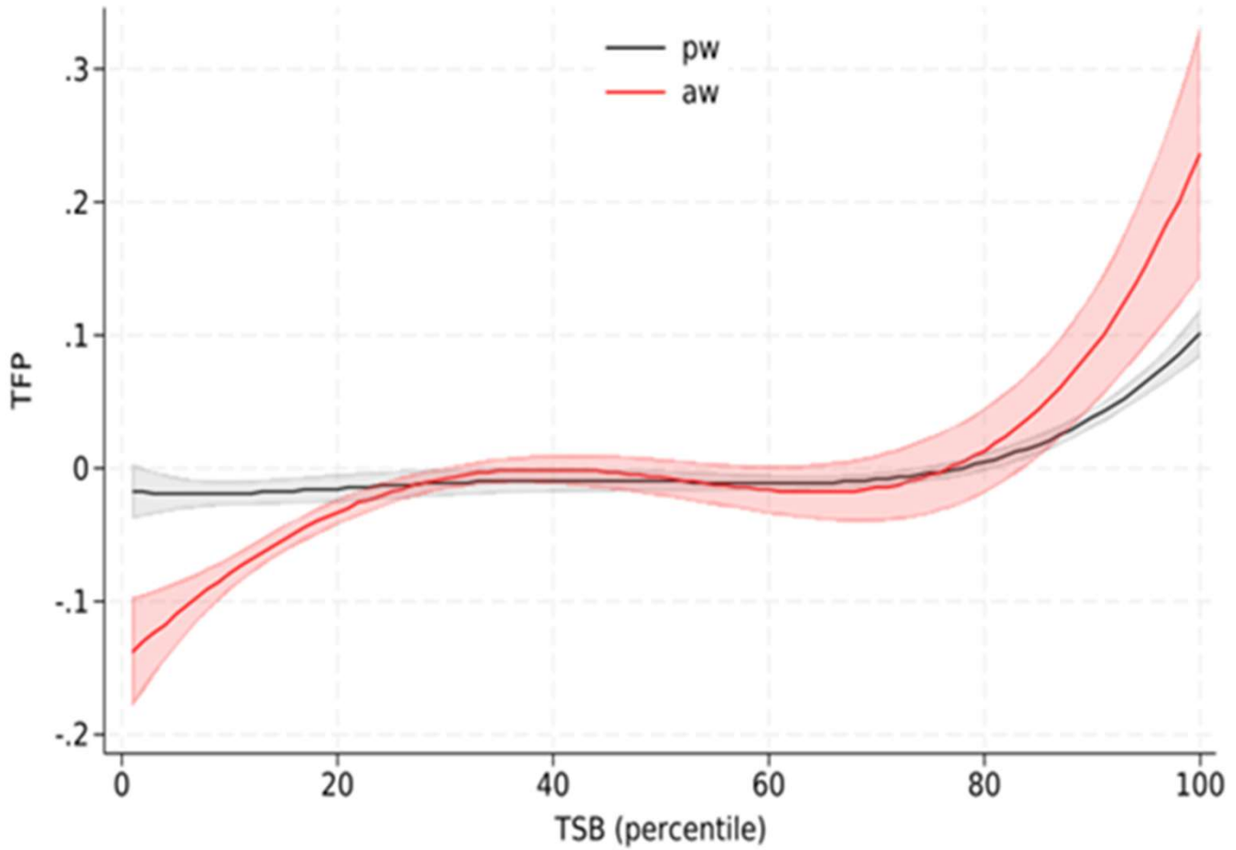
- Five aggregate tasks from Acemoglu and Autor (2011)
  - Non-routine (analytical)
  - Non-routine (interpersonal)
  - Routine cognitive
  - Routine manual
  - Routine manual (physical)
- For each task, we multiply the task content of each occupation by occupational employment and then calculate the average over all occupations.

Establishment-Level Task/Skill Intensity

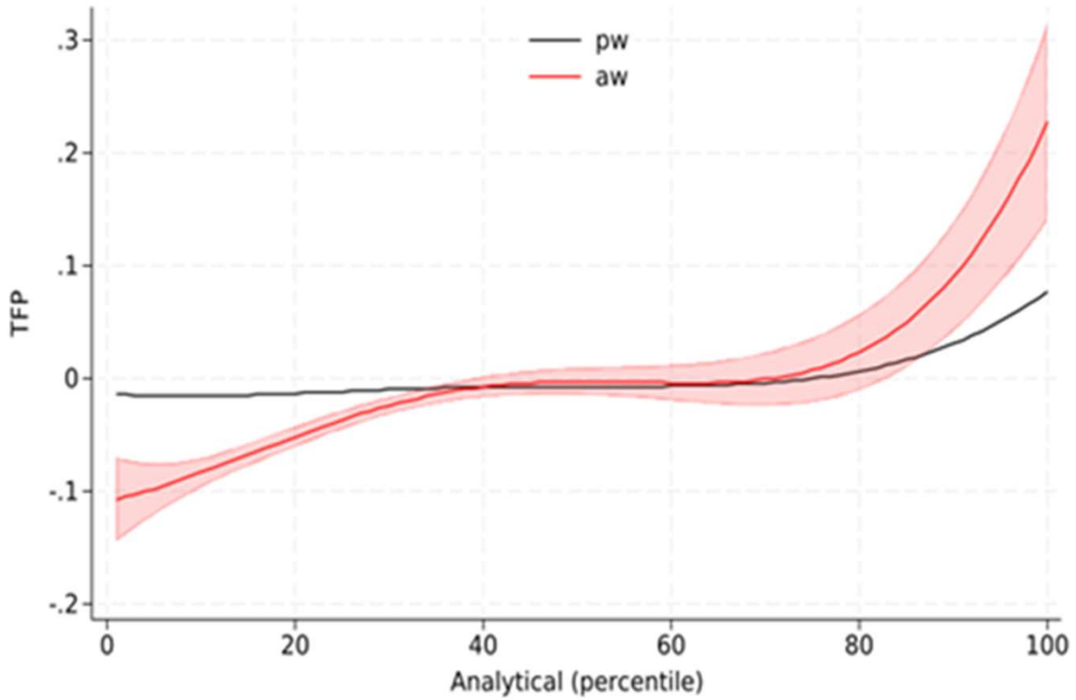
- **OEWS measure (TSB)** = the average wage for the establishment if the establishment paid the national average wage for each occupation
  - Tasks are bundled into occupations
  - Assumes that bundling matters
- **O*NET measure (TSU)** = the per worker average amount of each of 5 aggregate tasks (Acemoglu and Autor, 2011) times the price of those tasks (from a regression of the national occupation wage on task content)
  - Task/skill intensity is simply the average of tasks times the price of the tasks
  - Assumes that it does not matter who does what task
- Both measures account for tasks and skills.

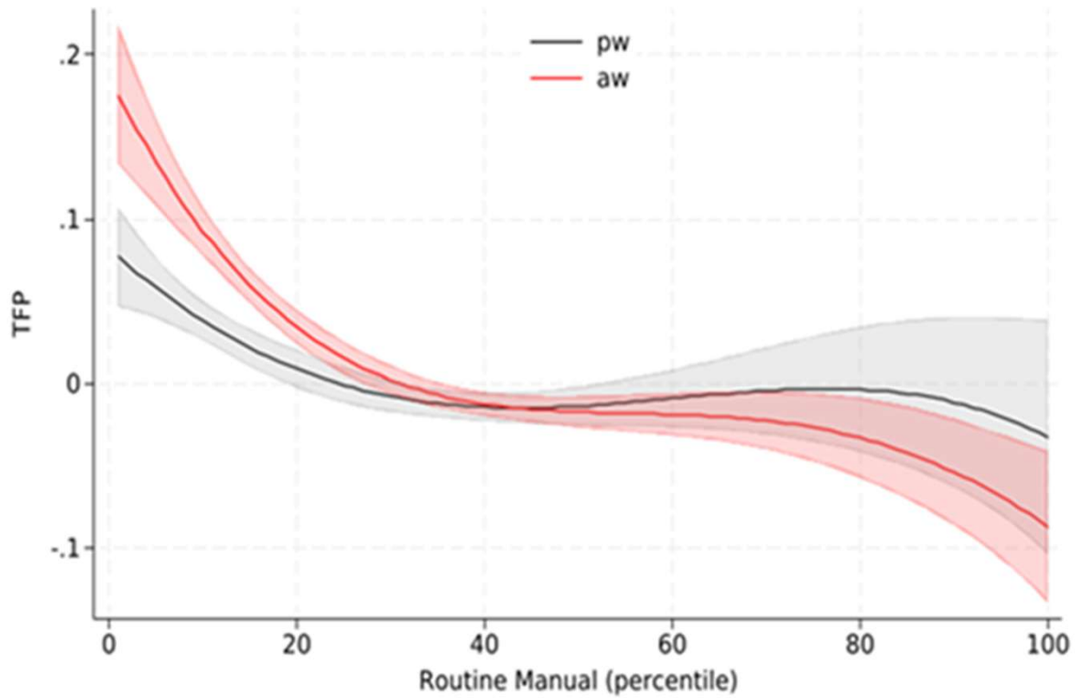
Nonlinearities 1

- The relationship between TFP and TSB:
  - is positive and highly nonlinear.
  - is stronger and nonlinearities more pronounced when we activity weight.



Nonlinearities 2





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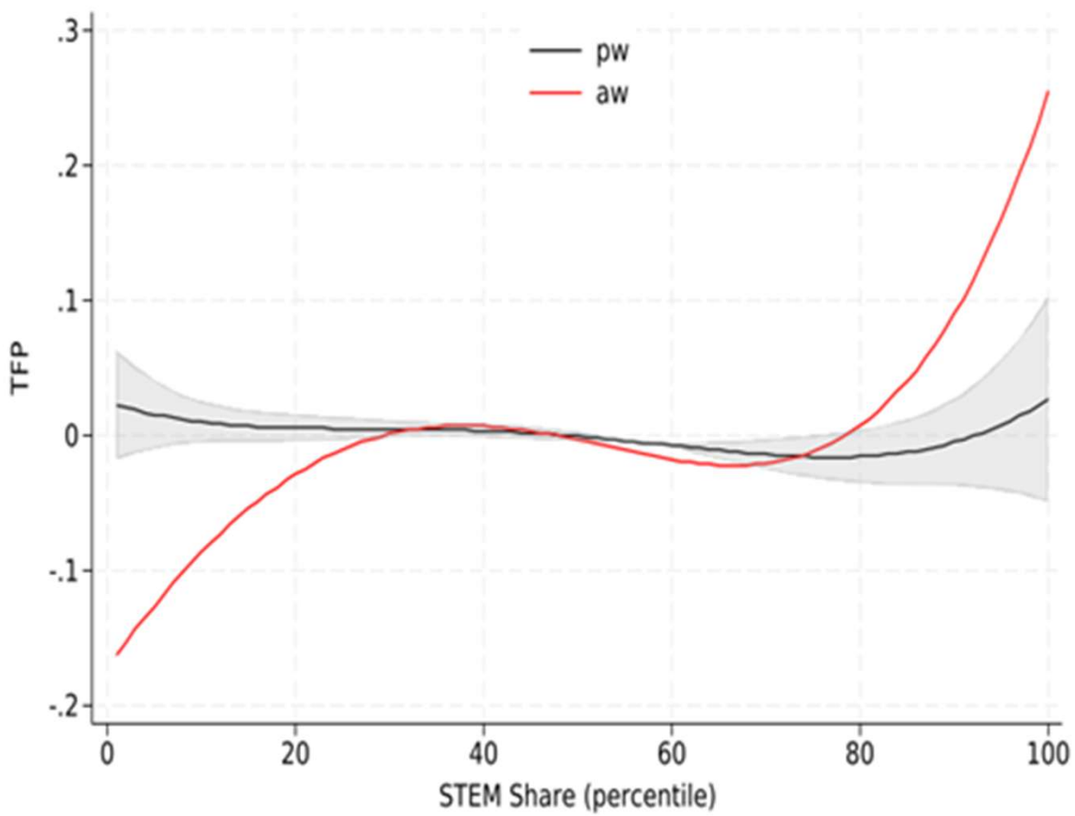
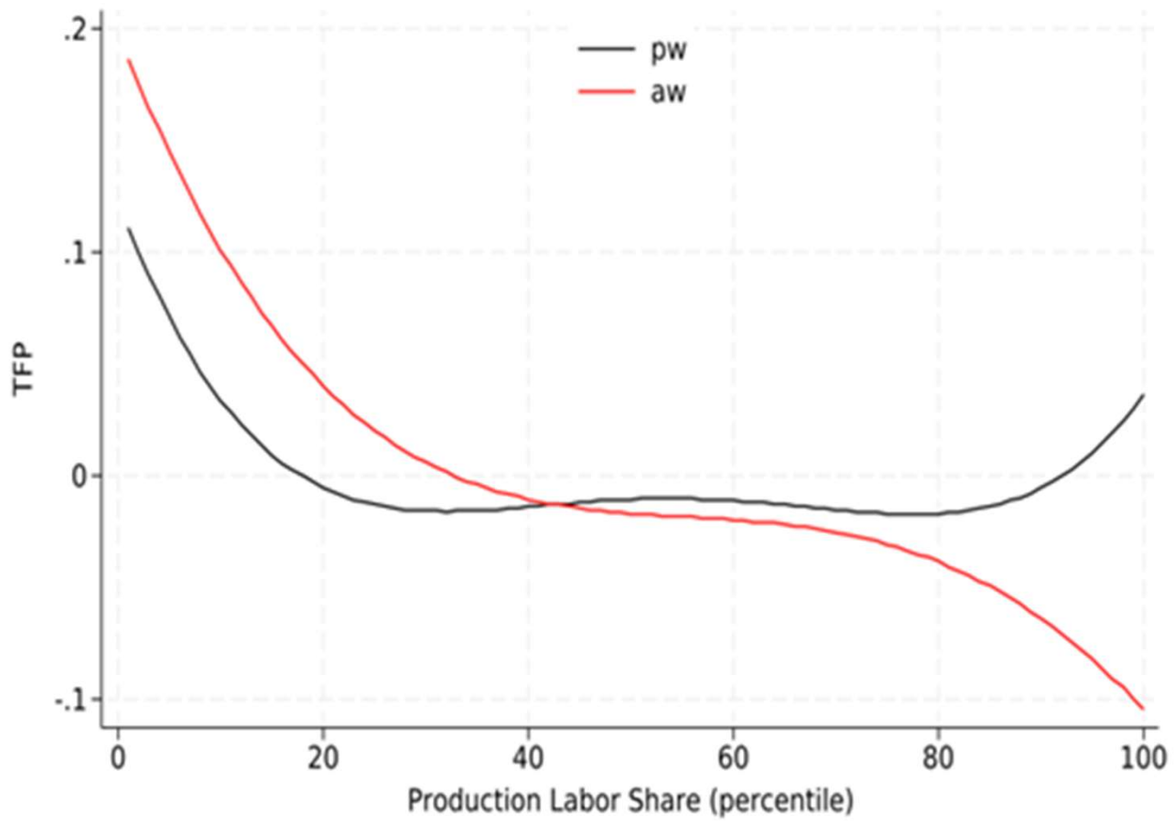
Nonlinearities 3





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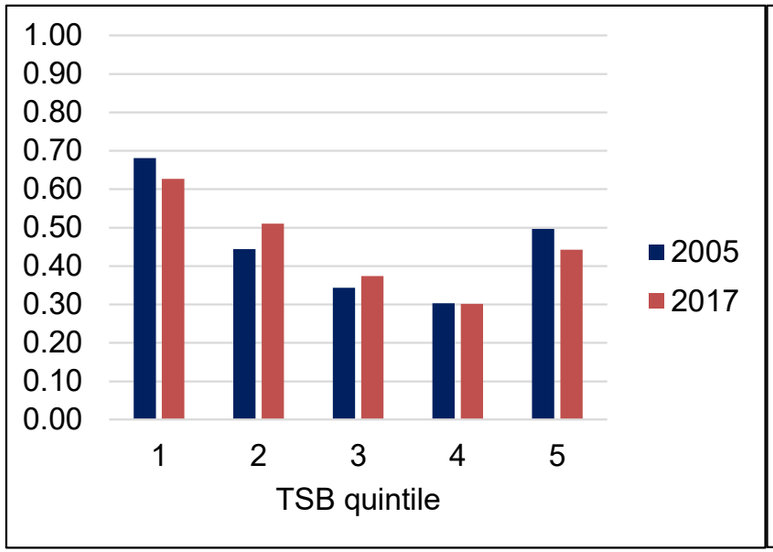
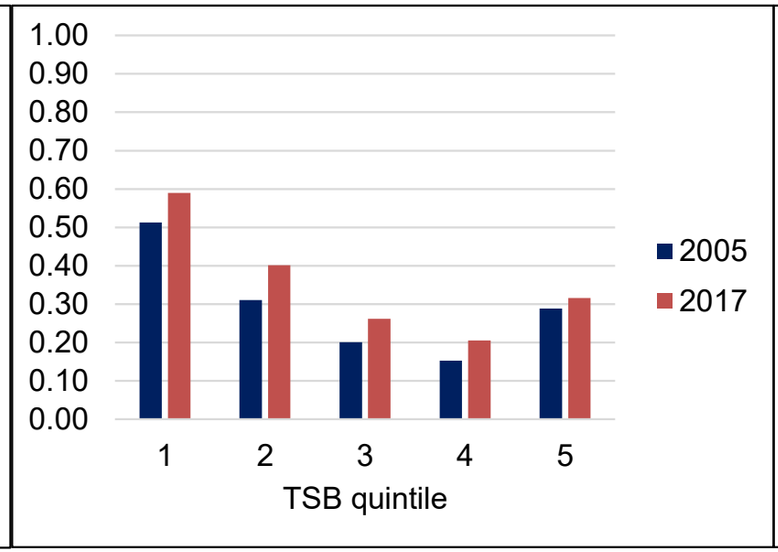
Within-industry Variation in Occupation Shares (activity weighted)

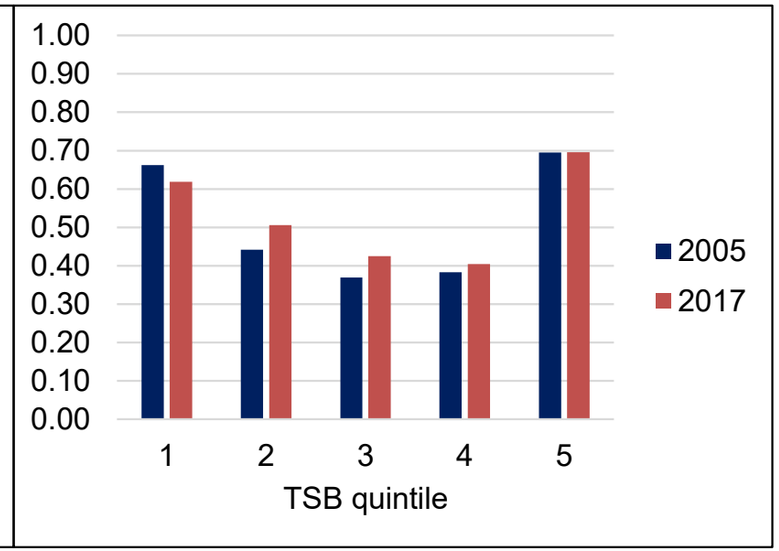
Production Worker



STEM



Management



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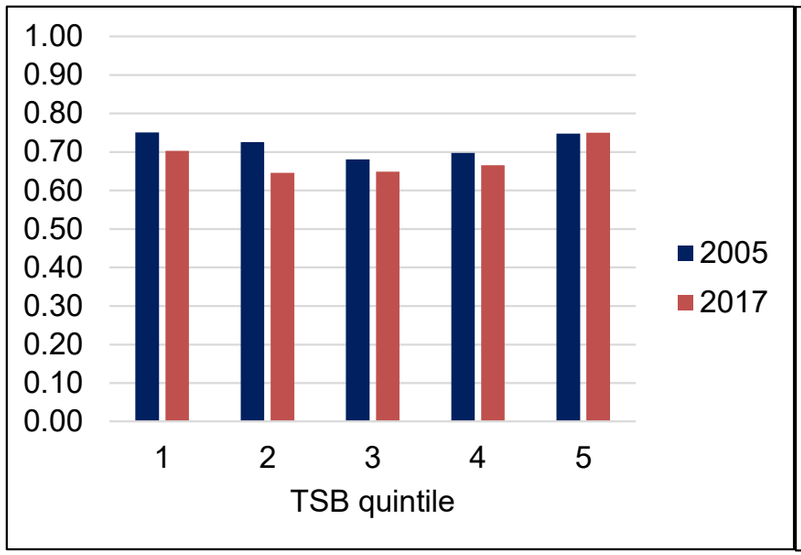
Within-industry Variation in Occupation Shares (PW only)

Production Worker



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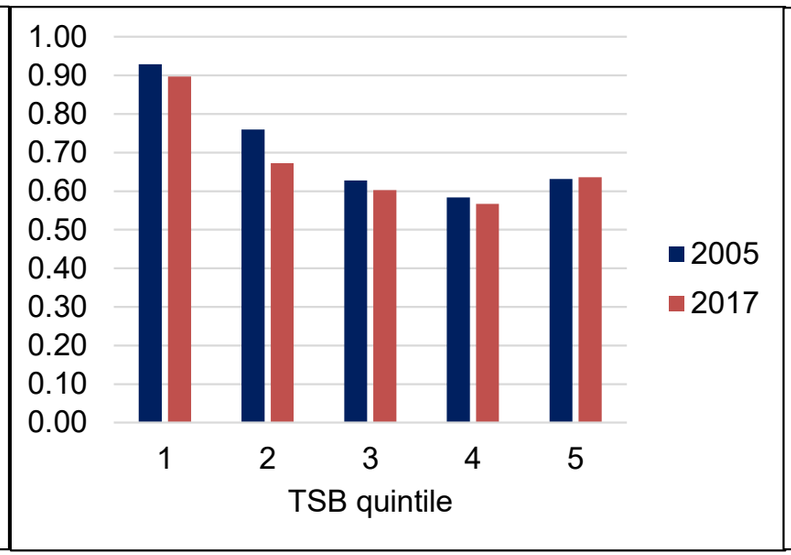

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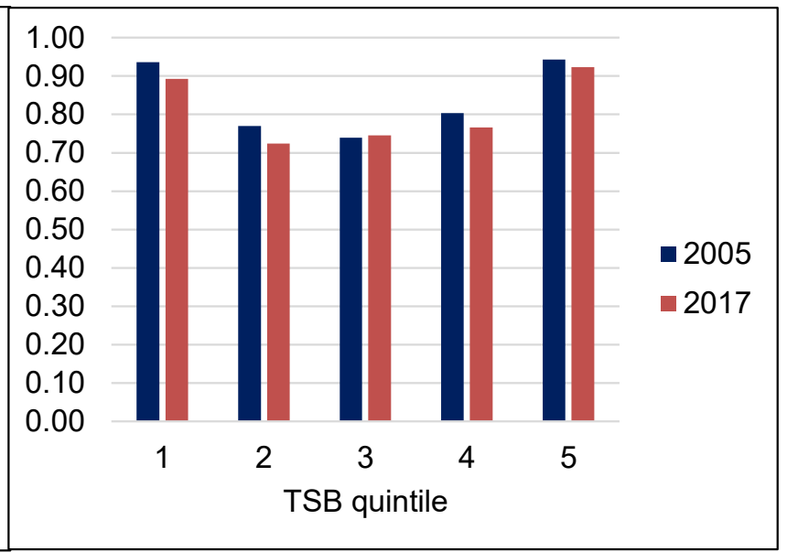

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Univariate Regression Results (activity weighted)

- Dependent variable = log(TFP)
- All coefficients have the expected sign and are highly significant.
- R-squareds are very low indicating that these variables account for almost none of the variation in TFP.
- Industry-specific interactions help a lot.

		Adj R-squared	
	Coef.	Univariate	Industry Interactions
TSU	0.58	0.02	0.10
TSB	0.45	0.02	0.09
Routine manual	-0.11	0.01	0.06
Routine cognitive	-0.07	0.00	0.01
Physical	-0.13	0.01	0.07
Interpersonal	0.09	0.00	0.05
Analytical	0.20	0.02	0.10
Production share	-0.31	0.01	0.08
STEM share	0.78	0.02	0.09
Management share	0.51	0.00	0.02

Multivariate Regression Results

Dependent Variable is log(TFP)	With Industry Interactions					
Regressions include industry interactions	All Manufacturing		High-Tech		Low-Tech	
	PW only	Activity	PW only	Activity	PW only	Activity
TSB + TSU + O*NET	0.05	0.14	0.06	0.25	0.05	0.13
TSB + TSU + O*NET + occ. shares	0.07	0.16	0.09	0.28	0.06	0.16
Poly(TSB + TSU + O*NET)	0.11	0.18	0.13	0.30	0.10	0.18
Poly(TSB + TSU + O*NET + occ. shares)	0.16	0.22	0.21	0.35	0.15	0.23

Summary

- The relationships between TFP and our task/skill/occupation measures are highly nonlinear and industry-specific.
- There are considerable within-industry differences in how establishments organize production.
- There is a complex relationship between these differences and measured TFP.
- The standard approach of using a Cobb-Douglas production function with common elasticities across all establishments in industries does not capture the heterogeneity and nonlinearities.

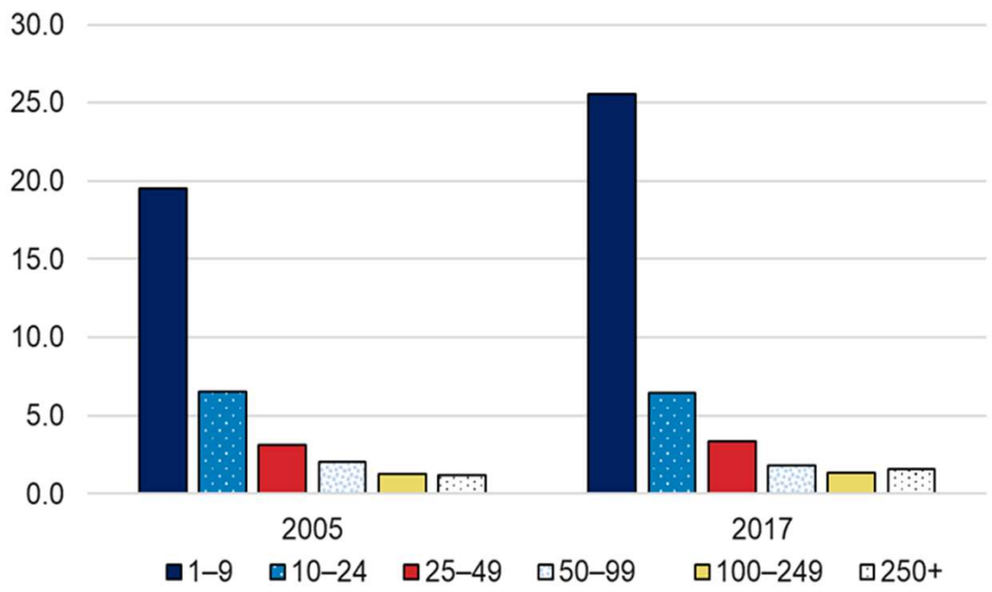
Future Directions:

- Learn more about what underlies within-industry variation in occupations and the nonlinear effects.
  - Can we learn more about technology adoption and the relationship between automation, tasks, and other factors of production?
  - How do we re-engineer the production function to better capture heterogeneity and nonlinearities?
  - How do these insights affect how we study the impact of technology adoption and innovation on firm and worker dynamics?

Future Directions: Factoryless Establishments

Fraction of establishments with zero production workers by:

Size Category



Selected Industries

	25 to 99 workers		100+ workers	
	2005	2017	2005	2017
High-Tech Industries				
Pharmaceuticals	14.1	6.5	1.1	2.2
Computer	17.2	25.3	25.4	22.0
Telecom equip	17.1	17.9	7.1	13.0
Semiconductor	8.7	4.5	1.3	6.1
Magnetic & Optical Equipment	28.1	9.5	16.5	38.2
Non-Tech Industies				
Tobacco	11.4	12.1	0.0	0.0
Concrete/cement	11.9	13.4	4.5	3.4
Autos/trucks	12.5	0.0	3.9	0.0

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Thank you

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